

What's Going on with our River?

Independent Report of Upper Barwon River Community Forum, October 2022



Produced for



Using this document

Discretion should be exercised in making decisions based on the data in this report.

Kismet Forward prepared this independent report based on feedback at a community forum.

This report provides an independent summary of the feedback received, which by its nature is subjective and not always consistent. It cannot *necessarily* be construed as an accurate reflection of the weight of broader community or stakeholder opinion. The report does not provide recommendations or opinions of the consultancy team. While no formal statistical analysis or fact-checking of data has been undertaken, significant effort has been made to accurately reflect the contributions of people who participated in this consultation.

This report has been prepared in line with the scope provided by Barwon Water and Corangamite CMA. Kismet Forward does not accept responsibility for any third party's use or reliance on this report.

Photos were supplied by Barwon Water and Upper Barwon Landcare Network.

Abbreviations and terms used

CMA	Catchment Management Authority
EJA	Environmental Justice Australia
LAWROC	Land and Water Resources Otway Catchment



Prepared by Jennifer Lilburn, Director, Kismet Forward
(jen@kismetforward.com.au)

Kismet Forward provides specialist advice and support in community engagement, facilitation, conflict management coaching, program logic, strategy, evaluation, training and project management. Further information can be found at www.kismetforward.com.au

Acknowledgement of Country

We acknowledge that the Community Forum took place on Eastern Maar Country, and thank Ebony Hickey for a moving Welcome to Country.

We recognise the Eastern Maar's unique ability to care for Country and their deep ongoing spiritual connection to it.

We honour their Elders, past, present and emerging and extend this respect to all Aboriginal and Torres Strait Islander people.



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1. Introduction

Project background

A Community Forum about the health of the Upper Barwon River was held in Forrest in October 2022. The event was hosted by Forrest Gerangamete Landcare Group in partnership with Upper Barwon Landcare Network, Corangamite CMA and Barwon Water.

The objectives of the Forum were:

- To increase Upper Barwon community members' understanding of issues surrounding the river's health and what can be done – and is being done – by authorities and individuals to improve it
- To give Upper Barwon community members an opportunity to have their questions and concerns surrounding river management addressed
- To inspire Upper Barwon community members to improve the river's health
- To enable CCMA and Barwon Water to consult with and inform community members about their aims and activities regarding the river.

Kismet Forward facilitated the Forum and produced this independent report. Its contents will inform the Barwon Flagship Project and other Barwon Water and Corangamite CMA activities. We hope it is also a handy reference for community members who took part.

After the Forum, participants toured accessible reaches of the East Barwon River.

2. Presentations

The Forum began with five presentations relevant to the Upper Barwon River. These included the responsibilities and projects undertaken by Barwon Water and Corangamite CMA and current and recent research projects by Alluvium Consulting and Deakin University students.

A snapshot of each presentation is below; the slides can be viewed at <https://www.yoursay.barwonwater.vic.gov.au/forrest-hub>

Barwon Water: river restoration and water supply

Will Buchanan, Chief Scientist/Manager Asset, Systems and Environment

Will's presentation covered the following:

- The Water for our Future Strategy, completed in May 2022, aims to deliver a secure water future through actions that transition the region to more climate-resilient manufactured water, embrace integrated water management opportunities and facilitate smarter water use
- The strategy was informed by more than 600 ideas and options shared and evaluated during the Water for our Future community engagement. This involved a dedicated Community Panel of 52 randomly selected community members.
- The current challenges are an increasing demand for water from population growth, agriculture and industry combined with a changing climate (hotter and drier) and a decline in the environmental health of rivers
- Barwon Water will deliver 10 actions over the next 5 years to increase water supply

capacity by 4,800 million litres, extending the next major supply upgrade timeline from 2027 to 2032

- At 17 October 2022, the total Geelong region water storage levels were at 99%
- Under the Upper Barwon Bulk Entitlement, water can be harvested from West Barwon Reservoir, East Barwon River, Callahan Creek, Dewing Creek, Matthews Creek and Pennyroyal Creek
- Barwon Water has removed willows that were inhibiting the flow of water from the East Barwon reach

In answer to questions, Will advised that

- Barwon Water is exploring options to manufacture water and better use fit-for-purpose recycled water (i.e. of a different standard for agriculture than for flushing toilets).
- He would provide further information about the options that were considered to increase the efficiency of the river system, including reducing evaporation. These options were considered in consultation with the Community Panel as part of the Water for Our Future program. (Further detail is in Appendix B)

River health technical assessments and FLOWS studies

Jamie Ewert and Emma Hodson, technical experts (Alluvium Consultancy)

Jamie and Emma's presentation covered the following:

- The Upper Barwon environmental flows study was updated in 2018, setting water recovery targets and environmental flow recommendations for the Upper Barwon (including East and West Branches), Yarrowee and Leigh Rivers, including 10 reaches
- The Upper Barwon restoration project identified constraints on the delivery of environmental water to and through the East and West branches and developed a program of works to address these constraints and progress riparian and channel restoration
- High-level assessment using aerial photography, site inspection and broad-scale modelling identified approximately 50 sites of potential constrictions to water flow. Constrictions included infrastructure, channel diversions and drainage and vegetation encroachment (including willows)
- Management options undertaken included willow removal and replacement, Glyceria control, Phragmites management, fencing and revegetation, physical stream interventions and off-stream watering
- The East Barwon water transfer and remediation project provided a rare opportunity to achieve multiple benefits in meeting Barwon Water's water transfer requirements (water security), removing willows in an 'upstream area', reducing erosion, improving water quality, restoring the environment and habitat and committing to ongoing maintenance

In answer to questions, Jamie and Emma stated:

- Decisions need to be made about prioritising environmental flows; these are guided by the Sustainable Water Strategy¹. Upper East and Upper West portions of the Barwon River system are priority reaches; the top of the catchment tends to have healthier ecology.
- Environmental assessments are based on field surveys and existing databases from a variety of sources. NatureKit² holds much of this information and is being built over time.

Corangamite CMA and the Barwon Flagship project

Leigh Dennis, Manager Strategy and Jayden Woolley, Estuaries and Environmental Water Manager

Leigh and Jayden's presentation covered the following:

- CMA roles and responsibilities under the Water Act, Land Act and Catchment and Land Protection Act
- Through the Barwon Flagship project, the CCMA oversees governance and coordination of activities in the Upper Barwon with an integrated waterway plan and Strategic Advisory Group
- Examples of on-ground works initiatives include the CCMA's facilitation of river health improvement works through landholder incentive programs and the commissioning of Monash University to seek feedback from landholders on water incentive programs and develop a new package to be trialled over the next two years
- Changes to the riparian works trial were outlined
- Works in the West Barwon to reduce the flood risk to Birregurra-Forrest Road saw the

¹ <https://www.water.vic.gov.au/planning/long-term-assessments-and-strategies/central-gipps-sws>

² NatureKit is a statewide biodiversity decision-support tool
<https://maps2.biodiversity.vic.gov.au/Html5viewer/index.html?viewer=NatureKit>

removal of 2.6km of Glyceria in March 2022, reducing the flood risk and altering flow and water levels in the short term. The CCMA will work with landholders to revegetate and create shade to reduce the risk of Glyceria reinvasion in the long-term

- Flows in the CCMA region are impacted by urban water extraction, and unlike some other CMA regions, the rural water impact on the Corangamite region is relatively small
- The CCMA manages the Upper Barwon Environmental Entitlement 2018. It aims to achieve ecological outcomes for the river and manage flows to achieve other 'shared benefits' where possible
- The planning process whereby the Regional Waterway Strategy and FLOWS Study lead to the Seasonal Watering Proposal, the Seasonal Watering Plan and finally to the Seasonal Watering Statement
- Six priority watering actions set the release or maintenance of flow volumes in the east and west branch for 2022-23
- The Central and Gippsland Region Sustainable Water Strategy outlines a policy to return up to 5 gigalitres of water to the Barwon River to improve waterway health by 2032

A community member asked for a description of Glyceria. Barwon Water provided the following image after the forum:



Evaluating restored riparian buffer zones

Mariah Sampson, PhD student (Deakin University)

Mariah's 2020-2023 project aims to understand stream restoration for water quality, stream morphology and ecology in the Upper Barwon Catchment.

The key research questions are

1. How does the restoration of a willow-dominated river reach impact the water quality, morphology and instream ecology and how does different vegetation?
2. How do different vegetation and restoration sites of different ages and sizes influence water quality, aquatic plant community composition and stream morphology?

Mariah's presentation also covered the following:

- Data collection sites cover willow, revegetated and thin-strip sites in 2020-2021 before restoration and in 2022-2023 after restoration
- Data collected includes aquatic plant surveying, vegetation surveying, water quality sampling, and morphology surveying. 4 rounds of water quality samples, 26 data loggers placed to record stream temperature, 3-6 channel morphology measurements per site and 10 surveys or riparian vegetation and 5 surveys of instream plants per site were collected

In answer to questions, Mariah stated that field samples are taken at various times, including when there are natural flows in the creeks and when there is no flow.

A summary of fieldwork in 2021-2022 is available in Appendix C.

A quantification model to assist in decision-making for waterway management

- James Malcher, Masters student (Deakin University)

James's research project is to develop a framework for quantifying economic and ecological trade-offs of altering riparian width on agricultural land.

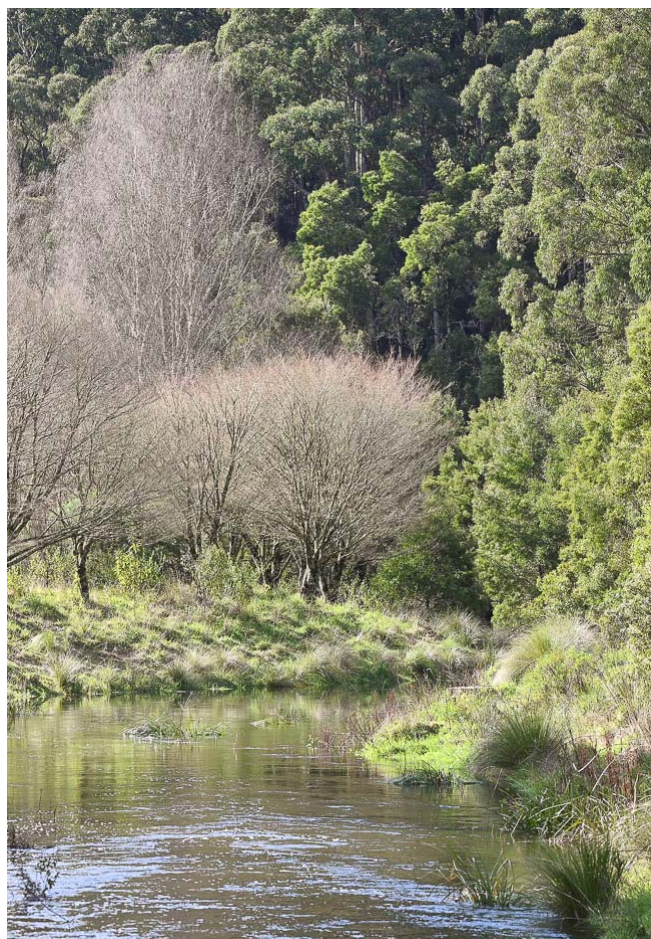
The objective is to build a decision-support tool that quantifies economic costs (production, revegetation, fencing) and ecological gains (carbon, habitat, water).

His presentation covered the following:

- James's model includes data on agricultural land suitability analysis, carbon sequestration, habitat distribution, revegetation and fencing costs and the estimated impact on water quality for 15,906 properties.
- The outcomes of this research could assist in the formulation of unique incremental revegetation plans, multifunctional accreditation systems and selective harvesting programs for individual primary producers

In answer to questions, James stated:

- Carbon credits are very difficult to acquire. We need to figure out a better way to value small-scale revegetation works in terms of carbon credits
- This area has such high growth conditions that the amount of carbon you can store in a relatively short amount of time is quite substantial. It is difficult to translate that into a dollar value.
- Blue carbon was not included in James's model.
- James can be contacted at jmalcher@deakin.edu.au for a copy of his research (once published – in a few months).



3. Panel

Panel composition

Six representatives of agency and community-based organisations participated in a Panel, answering questions from the audience and the facilitator.

The organisations represented were:

- Barwon Water (Will Buchanan)
<https://www.barwonwater.vic.gov.au/>
- Corangamite CMA (Jayden Woolley)
<https://ccma.vic.gov.au/>
- Eastern Maar Aboriginal Corporation (Brodey Hamilton) <https://easternmaar.com.au/>
- Environmental Justice Australia (EJA) (Juliet Le Feuvre) <https://envirojustice.org.au/>
- Friends of the Barwon (Lach Gordon)
<https://www.friendsofthebarwon.org.au/>
- Land and Water Resources Otway Catchment (LAWROC) (Neil Longmore)
<https://lawroc.wordpress.com/>

Summary of Panel discussion

Cultural significance and protection of Barwon River (Brodey Hamilton)

- Eastern Maar's goal is to get Country back to a healthy state – this is a goal we share with other organisations.
- The rivers are important culturally, spiritually and environmentally. They were the start of dreaming stories and were important for transport and communication. Rivers often formed the border between groups.
- Treaty will be important in enabling Traditional Owners to partner with natural resource organisations; this is consistent with water policy. We want to forge strong partnerships and increase our involvement.

Priorities for candidates/government following the election

- EJA: Get on with it. Take the water situation seriously and reduce the community's reliance on river water and groundwater. Put more water back into the river, not take it out. We need a similar push on water that we now see for renewable energy.
- LAWROC: legislate for more community involvement and empowerment in decisions about water.
- Friends of the Barwon: Commit to a public forum on potential water sources, supported by expert witnesses, including 'manufactured water' (to relieve extraction from rivers) and options for water recovery. Locally, we want an increase of the Upper Barwon Environmental Water Holding, licensing of small catchment dams, upgrading of the South Ballarat wastewater treatment plant, and no net loss of flow to the Moorabool following the closure of Fyansford quarry. We also want to see riparian per-urban issues urgently addressed.

Vision for the Barwon River

- Friends of the Barwon: A healthy, flowing, life-sustaining Barwon River system including the Yarrowie/Leigh, Moorabool and tributaries from source through the Ramsar wetlands to the sea.
- LAWROC: The community having a say in determining the health of rivers, major investment in restoring environmental flows, and decommissioning inefficient water channels.
- EJA: Not seeing the river as a resource, but as a living entity – with ecological, cultural and natural value. Protecting the river under a

Water Health Act, rather than thinking of it as a resource like it is under the Water Act.

- Corangamite CMA: The Corangamite Waterway Strategy 2014-2022³ has two visions:
 - Victoria's rivers, estuaries and wetlands are valued, healthy and well-managed, supporting environmental, social, cultural and economic values that are able to be enjoyed by all communities
 - A healthy Corangamite catchment valued by engaged communities.
- Barwon Water: The Water for our Future strategy includes the following vision for our water future:
 - A secure future where our rivers flow, our foods grow, and our impact is low.
 - Resilient, innovative and sustainable, with abundant water from a range of sources and where we actively protect and improve water for the environment.
 - Ethical, healthy and responsible, with affordable and equitable access for everyone.
 - A shared responsibility by valuing and conserving water and respecting the diverse needs of our community, cultures, and the environment.

Barwon Water added that community groups are pushing for change, partnerships, and a growing knowledge base about the system and what can be achieved. These are the ingredients needed for real change in the catchment.

Barwon Water – the importance of engagement

- Engagement with Mob: A key pillar of Barwon Water Strategy 2030 is listening and connecting with the community and Country. We're building relationships with all the Recognised Aboriginal Parties.
- Clearing of choke points in the river: Barwon Water is undertaking a staged works program to address willow infestation within the 4km section of the East Barwon River, where it is the delegated manager of the Crown water frontage⁴.
- Corangamite CMA has recently revised their grants program to encourage other Upper Barwon landholders with Crown land water frontage licences to help with this effort. The revised program has reduced the minimum buffer widths and increased funding rates to address the unique challenges in this system.

Does legislation protect the river?

- Barwon Water: Compliance with legislation doesn't mean there will be no impact. We are going beyond compliance with waterway rehabilitation and decommissioning the Barwon Downs borefield.
- EJA: The precautionary principle is in the Water Act, but it's not adequately applied. This is about intergenerational equity. Our saving grace is that many licences are not used. Concern about Barwon Water's ability to use 5KGL in an emergency. We should be wary of removing groundwater.
- LAWROC: There's a water justice issue – the water authorities and agriculture have a run on our water, even in dry periods. This has led to the degradation of the Leigh and Moorabool Rivers. The Water Act is not effective at allocating water to the environment.

³ https://issuu.com/gsdm/docs/waterway_strategy_2014-22

⁴ More information on this project can be viewed at <https://www.yoursay.barwonwater.vic.gov.au/east-barwon-transfer>

Impacts of willow removal

- Barwon Water: A thorough environmental approvals process was followed to ensure the necessary environmental safeguards were in place during on-ground willow removal works.
The initial removal of willows creates a scar on what is already a heavily modified environment.
- A publication *Upper Barwon River System: Mt Sabine to Winchelsea* (by Trevor and Pam Jennings) details how the river has changed over time and the historic removal of willows to improve flows.

After the Forum, Barwon Water provided the following additional information:

River restoration takes many years - it will take time for significant native instream habitat to return to the reach.

The following image show what the willow removal initially looked like:



As part of the works, existing native vegetation and instream habitat were retained where possible, as shown in the next image.



The following image shows the upstream reach that was restored in 2004 and provides an example of what we are aiming for in 10-15 years:



Further explanation is provided in Appendix A.

4. Feedback about the Upper Barwon River

Forum participants were invited to answer 3 questions about the Barwon River briefly.

Verbatim responses to the questions are below and have been provided to Corangamite CMA to include with other community contributions to the Barwon River Flagship Project.

What do you value most about the Barwon River?

- Life-giving and sustaining
- Wonderful habitat, the river is Life
- Water quality and habitat for native fish and wildlife
- Biodiversity
- Just having a river
- Interesting environment
- Whole ecosystem
- The natural environment that the Barwon River sustains
- Ecological value and diversity

How important is the Barwon River to you – and why?

- Very – ecosystem for wildlife and aesthetic environment
- Essential for wildlife, flora and us!
- Very important, water is life
- The river needs to be a living corridor across the land, NOT a drain

- Major element of Geelong's culture
- Is water of life
- Very important for wildlife and our environment
- Very important – the source of my water in Geelong and ecologically important
- A travel route for many species, including us

What would you like to see in/around the Barwon River in 10 years?

- Diversity of wildlife
- Sustainable access to the river via walking and bike tracks
- Sustainable First Nations tourism events
- A wall around it
- More native wildlife – quality and variety
- Improved river health, increased biodiversity, reduced agricultural access
- 29 GL/year environmental flows
- More native wildlife
- River fenced in farming areas and regenerated
- More river flow, fenced off entire river and revegetated
- Willows and weeds removed and more wildlife corridors

5. Citizen Science

Discussion continued during the after-lunch trip to the East Barwon. Deirdre Murphy, Regional Citizen Science Project Officer (Corangamite CMA), advised the following:

During our bus trip there was interest in platypus in the Barwon. Andrea Montgomery of UBLN has reports from the last 5 years for eDNA in the Barwon and tributaries. Also, the Great Australian Platypus Search (Odonata 2021) has a map showing results:

<https://www.thegreataustralianplatypussearch.org/results-2021> .

For information on River Blackfish in the Gellibrand, refer to the Native Fish Report Card at <https://www.ari.vic.gov.au/research/field-techniques-and-monitoring/native-fish-report-card-program> .

6. Where to from here

After the Forum, Barwon Water advised the following:

Barwon Water will continue to provide updates and information to the Upper Barwon community regarding our management of the Barwon water supply system, key projects and the delivery of our Urban Water Strategy and Water For Our Future Program.

To stay informed, please look out for updates in the Forrest Post and head to <https://www.yoursay.barwonwater.vic.gov.au/forrest-hub>

Barwon Water is also hosting a community information session on 1 December 2022 between 4-7pm at the Forrest Public Hall to provide an update on a range of projects and initiatives, including the Forrest Water Treatment plant upgrade, Forrest Wastewater Investigation and more.

More information on the Barwon River Flagship project can be found at

<https://ccma.vic.gov.au/projects/barwon-flagship-waterway/#:~:text=Upper%20Barwon&text=Flagship%20waterways%20are%20large%2Dscale,priority%20waterway%20within%20the%20region> .

Appendix A: Environmental safeguards for willow removal

After the Forum, Barwon Water provided further information on environmental safeguards for willow removal, specifically allowances for fish habitat in the East Barwon Willow Removal Project:

- A thorough environmental approvals process was followed to ensure the necessary environmental safeguards were in place during on-ground willow removal works. This included a number of environmental controls incorporated into the detailed design and technical specification development, obtaining a Works on Waterway permit from Corangamite CMA, and reviewing and monitoring the implementation of the principal contractor's environmental management plan during on-ground works.
- The objectives for the project were developed in consultation with an Agency Reference Group and Landholders. The key objectives of the project were to improve the flow of water in this reach of the river to allow Barwon Water to deliver its bulk entitlement from the West Barwon Reservoir to the Wurdee Boluc Inlet Channel, maintain the viable productive capacity of the floodplain and reduce water logging of neighbouring farmland, improve water quality and waterway health, and maintain and, where possible improve, cultural and environmental values.
- As part of the works, existing native vegetation and instream habitat was retained where possible
- We acknowledge that the willow removal works are quite intensive, however river restoration takes many years. The reality is that it will take time for significant native instream habitat to return to the reach.
- We are committed to the ongoing monitoring and management of this through our appointment as Committee of Management.
- In addition to our monitoring, we continue to provide funding to support the CCMA Citizen Science program (including a Waterwatch site within the project reach), and we are sponsoring Deakin University PhD researcher Mariah Sampson. The results of her research will provide a greater understanding of the impacts of willow restoration works on river health and water quality, which will help inform future management actions along with our long-term monitoring and evaluation of the reach.

Appendix B: Improving efficiency

Barwon Water provided the following information after the forum:

Barwon Water's Water for Our Future program considered options to reduce evaporation losses in the Wurdee Boluc Inlet Channel and Wurdee Boluc Reservoir.

The Community Panel ruled both options out due to the significant cost and limited volume of water that would be saved.

Information on the options and the Community Panel outcomes for each are provided on the following pages and via the following links:

https://www.barwonwater.vic.gov.au/_data/assets/pdf_file/0021/290334/Water-for-our-Future-Panel-2-report-March-2021.pdf

https://www.barwonwater.vic.gov.au/_data/assets/pdf_file/0024/290328/Water-for-our-Future-community-panel-background-report-2.pdf

Barwon Water has also previously explored the idea of floating solar arrays and found it is not feasible for Barwon Water's storages due to major technical and financial barriers. Even for our smallest raw water storages, covering the surface would require a large solar array, far in excess of the on-site electricity needs and exceeding the export capacity of the local grids.

For example, to cover Wurdee Boluc would require significant number of solar panels, and would make it the largest solar farm in Australia. To cover the surface would require 450 hectares of floating pontoons and would accommodate between 500 and 1500 megawatts (500,000 to 1,500,000 kilowatts) of panels, depending on spacing. Setting aside any grid capacity issues and the additional capital costs of floating solar, the economics do not stack up. It is clear that grid scale solar farms are not as viable in

southern Victoria, in comparison to northern Victoria or other states to the north.

We share your concerns about evaporation losses from Wurdee Boluc and are continually monitoring technologies and developments from around the world that could assist in reducing these losses. .

2. Improve Efficiency

Option 6: Improve efficiency – Barwon Water infrastructure – Minimising leaks – **Reduce losses along Wurdee Boluc Inlet Channel**

Description: With investment in replacing the existing West Barwon to Wurdee Boluc channel with a pipeline over a 50 km section of open transfer infrastructure, water losses of approximately 400 ML/y can be recovered. The predominantly earthen-lined channel loses water due to seepage over the seasonal operating period.

This option was not recommended by Water for our Future Community Panel. Visit www.barwonwater.vic.gov.au/future to read the panel's report.

Social Impact & Equity			
Extent of shared social benefits/costs		G	Water security benefits shared across Greater Geelong water supply system.
Extent of private investment required		G	No private investment required by customers, cost of option would be passed on via Barwon Water bills.
Community & Social Outcomes			
Bill impact – household owner/occupier		\$39	
Bill impact – household renter		\$13	
Bill impact – small business		\$64	
Bill impact – large business		\$7,605	
Health benefits		A	No known health benefit.
Social and recreational benefits		A	No known social/recreational benefit.
Employment benefits		G	Provides employment benefit – up to 371 full time equivalent positions from capital investment.
Environmental			
Environmental impacts – water		G	Does not have significant additional impacts on aquatic environments.
Environmental impacts – land & biodiversity		A	Some limited construction activity in potentially sensitive environments.
Zero net emissions		G	No greenhouse gas emissions required to be offset.
Rainfall dependency		A	Ultimately dependent on rainfall for there to be water to transfer via the channel.
Sustainability			
Ability to enable the sustainable use or reuse of resources		G	Provides a more efficient use of a limited resource – less water lost via seepage and leakage.
Promotes informed water use		R	Water would be delivered to and used by customers in the same way as now.
Technology, Science & Innovation			
Time required to implement		10–20 years	
Regulatory, legislative or policy constraints		G	Does not have regulatory, legislative or policy constraints.
Near-term yield (in 10 years)		0 ML/year	
Long-term yield (in 50 years)		400 ML/year	
Certainty of yield		G	High level of confidence given existing infrastructure, history of use in the area and ongoing need to transfer water.
Scalability		A	Limited opportunities to apply in other areas to receive similar benefit but works could be staged over time.
Finance & Economics			
Capex		\$200M	
Opex		\$200/ML	
Levelised cost		\$35,679/ML	

High-level, preliminary information provided as a guide only – represents views of Barwon Water professionals and should not be viewed as definitive or exhaustive

2. Improve Efficiency

Option 7: Improve efficiency – Barwon Water infrastructure – Reducing evaporation – **Shade balls at Wurdee Boluc Reservoir**

Description: This option involves floating millions of food grade plastic shade balls on the surface of Wurdee Boluc Reservoir to reduce losses that occur via evaporation and wind generated wave action. A 70 per cent surface area coverage has been assumed with 75 per cent efficiency, resulting in approximately 2,730 ML/yr of water gained. Given the size, wind and wave action of such a large storage, the use of floating shade balls would create a flexible, modular barrier to the elements.

This option was not recommended by Water for our Future Community Panel. Visit www.barwonwater.vic.gov.au/future to read the panel's report.

Social Impact & Equity		
Extent of shared social benefits/costs	G	Water security benefits shared across Greater Geelong water supply system.
Extent of private investment required	G	No private investment required by customers, cost of option would be passed on via Barwon Water bills.
Community & Social Outcomes		
Bill impact – household owner/occupier	\$25	
Bill impact – household renter	\$8	
Bill impact – small business	\$41	
Bill impact – large business	\$4,874	
Health benefits	A	No known health benefit.
Social and recreational benefits	R	Reduces existing social/recreational benefit to the community – installation of shade balls would prevent current approved recreational fishing at the reservoir.
Employment benefits	G	Provides employment benefit – up to 226 full time equivalent positions from capital investment.
Environmental		
Environmental impacts – water	G	Does not have additional impacts on the aquatic environment.
Environmental impacts – land & biodiversity	G	Does not have additional impacts on land and biodiversity. No construction required.
Zero net emissions	G	No greenhouse gas emissions required to be offset.
Rainfall dependency	A	Ultimately dependent on rainfall for there to be water in Wurdee Boluc Reservoir.
Sustainability		
Ability to enable the sustainable use or reuse of resources	G	Provides a more efficient use of a limited resource – less water lost via evaporation.
Promotes informed water use	A	May provide some interest and visual engagement.
Technology, Science & Innovation		
Time required to implement	3–5 years	
Regulatory, legislative or policy constraints	A	Some regulatory constraints – would require environmental and health approvals.
Near-term yield (in 10 years)	2,730 ML/year	
Long-term yield (in 50 years)	2,730 ML/year	
Certainty of yield	R	Approach has not been applied in our region. Currently a low certainty of yield – risk that shallow nature of storage and high winds at Wurdee Boluc Reservoir mean this technology is not applicable or feasible.
Scalability	R	Not scalable for Wurdee Boluc Reservoir – potential to apply across other, smaller water storages but yield would be less.
Finance & Economics		
Capex	\$122M	
Opex	\$300 /ML	
Levelised cost	\$5,095 /ML	

High-level, preliminary information provided as a guide only – represents views of Barwon Water professionals and should not be viewed as definitive or exhaustive

Appendix C: 2021-22 Fieldwork Summary

The 2021-22 Fieldwork Summary report to support Mariah Sampson's research: *Evaluating restored riparian buffer zones in temperate streams* is on the following pages.

Evaluating restored riparian buffer zones in temperate streams

Mariah Sampson, PhD Candidate, *Quantitative Aquatic Ecology Lab*
Centre for Regional and Rural Futures, Deakin University

A report on the 2021-2022 Fieldwork Season

What is this research part of?

A PhD project to evaluate riparian buffer zones in agricultural streams. This includes looking at how the length and width of riparian buffers impacts water quality, as well as sampling to monitor the ecological response to willow restoration works along the East Barwon River.

What questions are we trying to answer with field work?

1 How does restoring the vegetation in the riparian zone at a willow infested site influence water quality, instream ecology, and stream morphology?

2 How do riparian vegetation types and restorations of different ages and widths influence water quality, instream ecology, and stream morphology?

What types of data were collected?



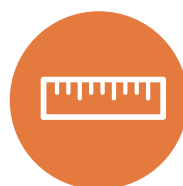
4 rounds of water quality samples



10 Surveys of riparian vegetation and
5 Surveys of instream plants per site



26 Data loggers placed to record stream temperature



3-6 Channel morphology measurements per site

Where was data collected?



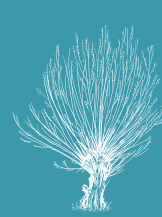
11 SITES

Across 5 streams in the Upper Barwon Catchment



UP TO 3 KILOMETRES

Stream sections ranged from 400m - 3km in length



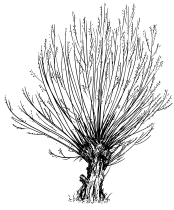
3 VEGETATION TYPES

Willow lined
Revegetated
Blackwood lined

Fieldwork Season 2021-2022

Data Summary

What are the different vegetation types?



Willow

Willow sites are where the dominant riparian vegetation are invasive willow trees (*Salix spp.*). These are considered the "control" sites of the study and data collected here will look at building a picture of how willow trees influence water quality, stream ecology and morphology in the Upper Barwon catchment.



Revegetated

Revegetated sites are where stock have been excluded and native species have been planted, often following the removal of willows. Data collected from these sites will be compared to willow and blackwood sites to help measure how revegetation impacts the stream, as well as how the length, width, and age of a revegetation might impact these variables.



Blackwood lined

Blackwood sites are where the dominant riparian tree species are Blackwoods (*Acacia melanoxylon*) that may be growing naturally or have been planted. Data collected from these sites provide a reference example to conditions where there are neither willows nor revegetation.



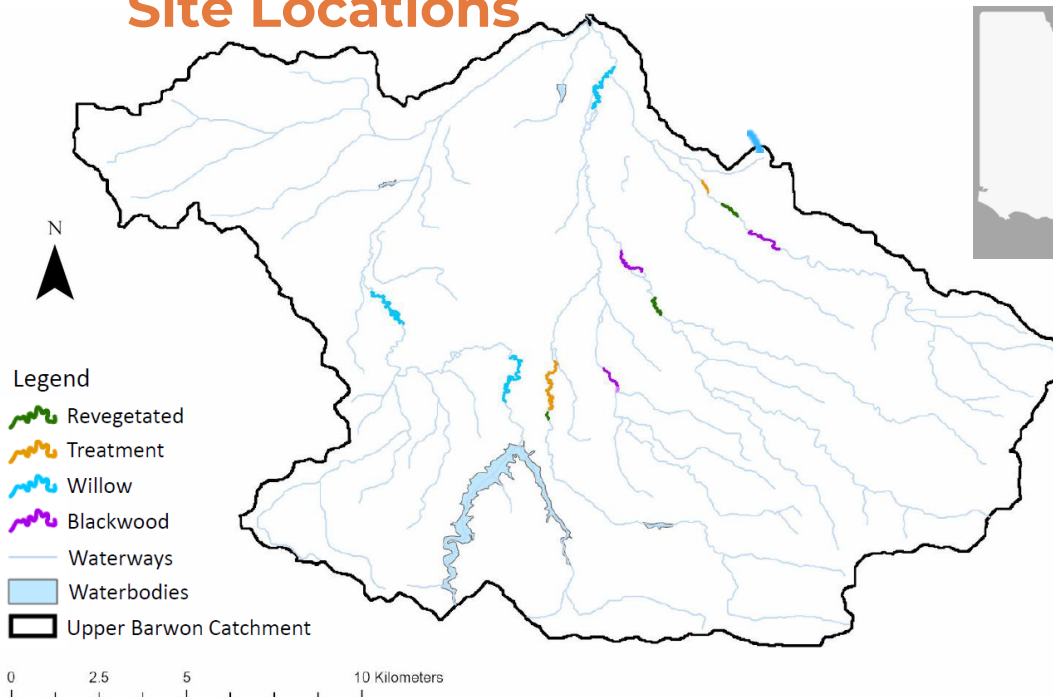
Treatment

The treatment site, is a 3km reach of the East Barwon River that is undergoing willow removal and revegetation. One of the goals of this PhD research is to monitor this site and compare the changes that occur with results from willow sites.

The removal of willows for revegetation is a disturbance followed by a recovery process. Improving our understanding of the short-term impacts and long-term recovery of willow removal and revegetation is important for the future design and implementation of willow removal projects.

The water quality data collected in the 2021 Spring/Summer season can tell us only the first part of the restoration story, how this site responds over time to is a key focus of the PhD research project.

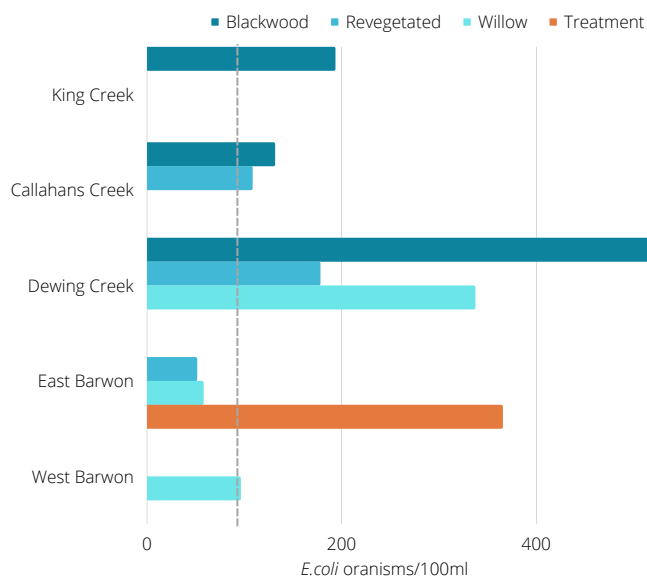
Site Locations



Thank you so much to everyone who participated by allowing access to the streams on your properties.

Fieldwork Season 2021-2022

Data Summary



E. coli(org/100mL)

The amount of *E. coli* in freshwater is an important indicator for drinking water safety, and its presence is often used as proxy for more harmful bacteria.

Riparian buffer zones have been shown to help limit the run-off of *E. coli* into streams.

The safe amount of *E. coli* in drinking water is 0 organisms/100mL and 130 organisms/100mL for recreational activities.

The results

The amount of *E. coli* in rivers can be influenced by factors such as temperature, rainfall, the disturbance of sediment, and the presences of livestock in nearby fields.

While the averages in the graph are useful to help visualise the data, it is important for analysis that the influence of rainfall and other variables are considered.

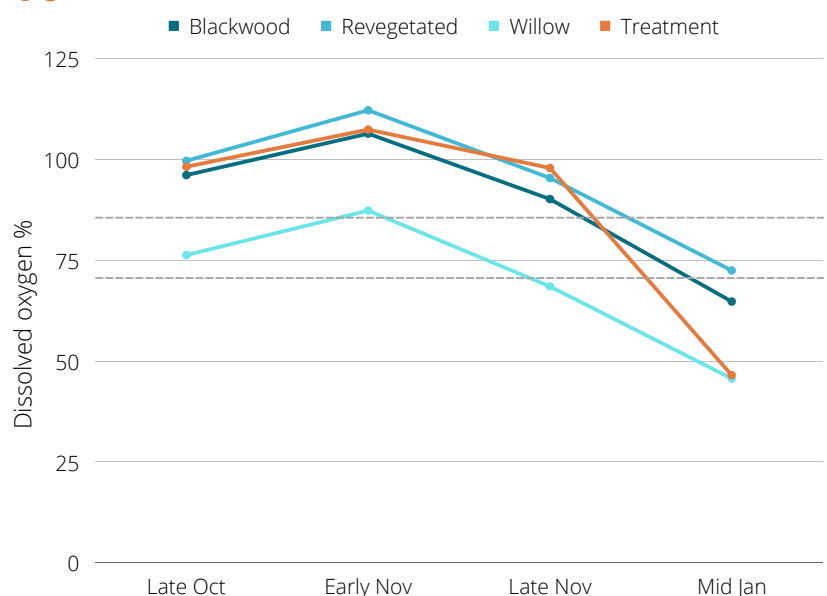
A targeted investigation into the *E. coli* levels is currently being developed for inclusion in this PhD.

Dissolved oxygen %

Dissolved oxygen (DO) is the oxygen available in water for aquatic species, such as fish to breath.

The amount of DO in water can be influenced by the amount of decomposing organic material in a stream, bacteria and seasonal changes such as temperature and the flow of a river. DO is usually collected as part of a suite of indicators for water quality.

The Victorian reference for DO is >70% for the Otway Plains and >85% for the Otway Ranges.



What does this all mean?

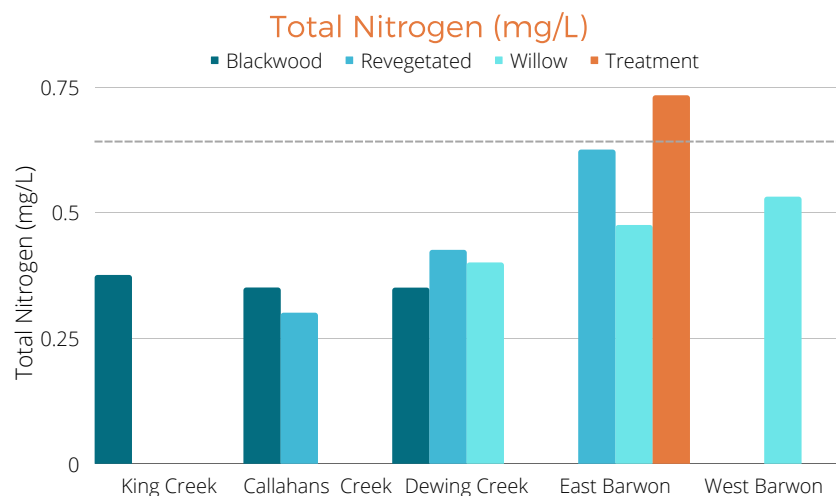
Data collection is just the beginning of the research. Data analysis, and in some cases follow up sampling are all needed to understand these results and answer the research questions.

PhD progress



Fieldwork Season 2021-2022

Data Summary



Nutrients

Nitrogen and phosphorous levels are naturally low in Australian ecosystems.

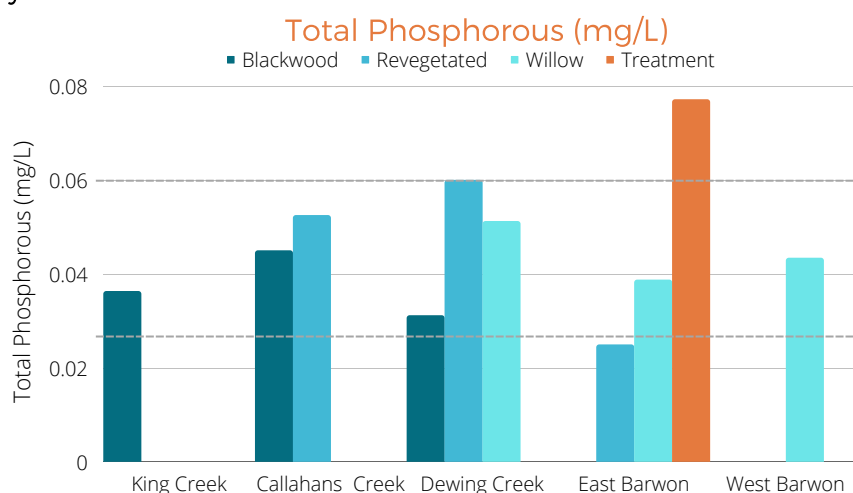
High quantities of nutrients can promote algal blooms and lead to reduced water quality.

Nutrients often enter streams as an agricultural byproduct. Rainfall can also influence this, as can the surrounding land-use, such as the fertilisation of pastures.

The results

These graphs show a grouping of averages by vegetation category and creek. The nutrient levels are generally low, but as with E. coli, further analysis is needed to better understand what drives these results.

Reference levels for nutrients	Otway Plains	Otway Ranges
Total Nitrogen (mg/L)	<1.1	<0.65
Total Phosphorous (mg/L)	<0.060	<0.025



Acknowledgements

Thank you so much to everyone who participated by allowing access to the streams on your properties.

I show my respect and acknowledge the Eastern Maar and Wadawurrung people who are the Traditional Custodians of the Land on which this research takes place, and to Elders past and present.

PhD Supervisors

Prof. Rebecca Lester & Dr Ty Matthews



Sponsors

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